

## **Evidence of airborne contamination of western North American mountain ecosystems**

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**There is emerging evidence that mountain ecosystems in the western USA are receiving deposition of persistent bioaccumulative toxicants (Au: toxins?) with origins in North America and elsewhere in the Northern Hemisphere. The toxic materials include metals and organic compounds. Of particular interest is Mercury (Hg) and a long list of man-made semi-volatile organic compounds (SOCs) which include many older compounds like DDT, PCB, Toxophene as well as current use chemicals and pesticides. These contaminants are produced by industrial activities throughout the world. In the case of Hg, there are natural sources, but anthropogenic sources dominate the global Hg cycle.**

These contaminants are deposited via rain, snow and dry deposition, but in many high elevation locations snow is the dominant form of precipitation and, therefore, the major pathway bringing contaminants from the atmosphere to the mountain catchment (2). We sampled late spring snow pack in two montane watersheds (2207 and 3495 m.a.s.l.) located on opposite sides of the Sierra Nevada divide (California, USA) in April 1994, to evaluate organic contaminant loadings. Clean field sampling techniques were used to minimize contamination and the samples were analyzed for a broad suite of SOC contaminants. Results suggest that not only is the Sierra Nevada receiving deposition of these materials at both sites, but also concentrations of the more volatile constituents (e.g. HCH, Endosulphan) increase with elevation following the cold fractionation phenomena (4). These data are very comparable with a study in the southern Canadian Rocky Mountains conducted one and two years after the Sierra samples (Figure 1; 1). Samples were collected using identical procedures and analyzed in the same Canadian laboratory. Combined, these data suggest that there are consistent patterns of contaminant deposition in temperate, western North America that may persist over multiple years. We know little about bioaccumulative processes at these high elevation sites that might put populations of aquatic and terrestrial ecosystems at risk if organisms incorporate contaminants through the food web (Refer to Mountain Science Highlights by McDonald and Elliot).

The National Park Service in cooperation with the USEPA and other federal agencies and universities has implemented an interdisciplinary Western Airborne Contaminants Assessment Program that is located in seven U.S. National Parks in an effort to evaluate elevation and latitude gradients with respect to airborne contaminants in lakes and their catchments. Sites range along the western border of the US from the Arctic to the Sierra Nevada and inland to the Rocky Mountains. A broad suite of organic compounds and heavy metals will be analyzed in various media (e.g. snow, water, fish, vegetation, sediment). An integrated sampling design will be used to maximize the potential for risk evaluation at various temporal and spatial scales. Results from this effort will be compared to concurrent and recent Canadian and European efforts designed to meet many of the same objectives using compatible approaches (3). This first effort is designed to determine if there is a broad scale problem with respect to airborne contaminants in mountains in the western USA. Methodologies developed in this program will be considered for incorporation into future monitoring and inventory programs being designed by the National Park Service.

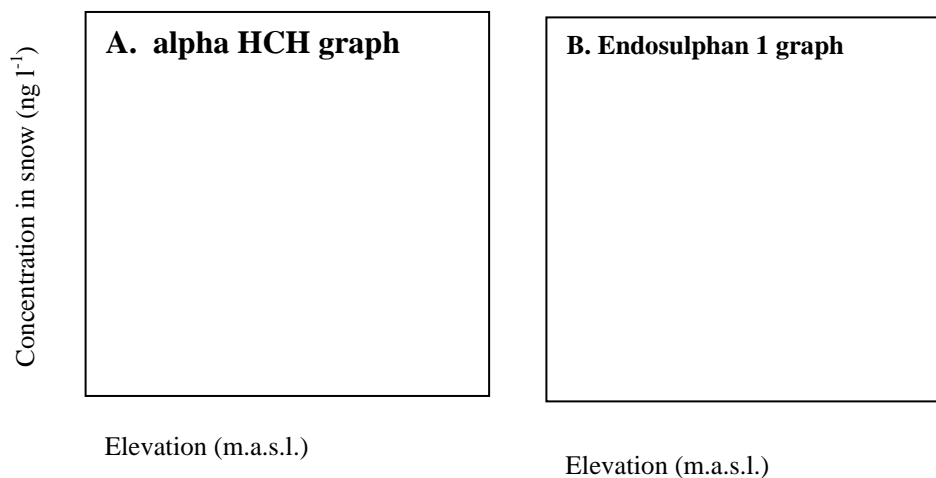
**Au: Air transport concerns: 1. Long range-transoceanic/ transpacific (Robie MacDonald); 2. Local transport-urban, industrial, agriculture (Tonnessen); 3. Cold Condensation-processes upslope-Why care about air toxins in Mtns? High elevations & high latitudes are “sinks” for air toxins.**

**Au: It is critical for Blais, MacDonald, Landers & Elliott to review each other's Science Highlights to make complementary & reduce overlap.**

## References

**(Au: give website for WACAP?)**

1. Blais, J. M., D. W. Schindler, et al. (1998). "Accumulation of persistent organochlorine compounds in mountains of western Canada." Nature **395**(08 October): 585-588.
2. Carrera, G., P. Fernandez, et al. (2001). "Persistent organic pollutants in snow from European high mountain areas." Atmospheric Environment **35**: 245-254.
3. Grimalt, J. O., F. Pilar, et al. (2001). "Selective trapping of organochlorine compounds in mountain lakes of temperate areas." Environ. Sci. Technol. **35**(13): 2690-2697.
4. Wania, F., J. Haugen, et al. (1998). "Temperature dependence of atmospheric concentrations of semivolatile organic compounds." Environmental Science & Technology **32**(8): 1013-1021.



*Figure 1. Comparison of Persistent Organochlorine Compounds in Western Canada and the Sierra Mountains. Canadian Data From: J. Blais et al. 1998. Nature 395:585-588. Unpublished data from D. Landers (USEPA) plotted over Blais et al. (1998).*